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Animal Behaviour in Zoopharmacognosy

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Commentary

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DESCRIPTION

Zoopharmacognosy is the pattern of behaviour of nonhuman animals that appears to self-medicate by selecting and ingesting or topically applying plants, soils, insects and psychoactive drugs to prevent or reduce the harmful effects of pathogens and toxins. When dogs eat grass to induce vomiting, this is an example of zoopharmacognosy. However, the behaviour is much more varied than this. Non-foods such as clay, charcoal and even toxic plants and invertebrates are ingested or applied by animals, ostensibly to prevent parasitic infestation or poisoning. The question of whether animals truly self-medicate remains somewhat contentious because early evidence was mostly circumstantial or anecdotal however, more recent studies have taken an experimental hypothesis-driven approach. The methods by which animals self-medicate vary but can be classified as prophylactic.

The behavior is thought to have broad adaptive significance. Several animals consume or relate the substance when they appear to be healthy, implying that the behavior is preventative or prophylactic. In other cases, animals ingest or apply the substance when they are sick, implying that the behavior is therapeutic or curative. There are three methods of self-medication: Ingestion, absorption and topical application. Apes have been observed swallowing whole leaves without chewing for over 40 plant species.

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Wild chimps will occasionally seek whole *Aspilia* plant leaves. These contain thiarubrine-A, a chemical that is active against intestinal nematode parasites but it is quickly broken down by the stomach. The chimps pick the Aspilia leaves and rather than chewing them, roll them around in their mouths for up to 25 seconds. The capsule-like leaves are then ingested whole. In each bout of this behavior, as many as 15 to 35 *Aspilia* leaves may be used, especially during the rainy season when there are many parasitic larvae, increasing the risk of infection. Non-chewed stem-strips of acacia are sometimes swallowed by bonobos. Despite the fact that the plant is abundant throughout the year, *M. fulvum* is consumed only at specific times, in small amounts and by a small proportion of bonobos in each group.

Many parrot species in the Americas, Africa, and Papua New Guinea eat kaolin or clay which releases minerals while also absorbing toxic compounds from the gut. Great Indian Bustards eat *Meloe* blister beetles to reduce parasite load in the digestive system cantharid in, a toxic compound in blister beetles can kill a great Indian bustard if too many beetles are consumed. To increase male sexual arousal, great Indian bustards may consume toxic blister beetles of the genus *Meloe. Tachinid* flies can be lethal endoparasites of woolly bear caterpillars. The caterpillars consume plant toxins known as pyrrolizidine alkaloids which improve their survival by conferring resistance to flies. Importantly, parasitised caterpillars are more likely than non-parasitised caterpillars to consume large amounts of pyrrolizidine alkaloids and excessive consumption of these toxins reduces non-parasitised caterpillar survival. These three findings all support the adaptive plasticity theory. The tobacco hornworm consumes nicotine which reduces colony growth and toxicity of *Bacillus thuringiensis* resulting in increased hornworm survival. Ants infected with the fungus *Beauveria bassiana* selectively consume harmful substances (reactive oxygen species, ROS) when exposed to a fungal pathogen but avoids them when not infected.

When sick, a variety of simian species have been observed using materials such as plants to medicate themselves. Pre and post-ingestive events control the manifestation of self-meditative behaviour in mammalian herbivores, according to this conceptual model. Great apes frequently consume plants that have no nutritional value but have beneficial effects on gut acidity or combat parasitic infection in the intestine. Chimpanzees will sometimes chew on bitter leaves. After chimps chew the leaves of pith which have anti-parasitic activity against schistosoma, *plasmodium* and *Leishmania*, parasite infection decreases noticeably. Chimpanzees do not consume this plant on a regular basis. Chimpanzees every now and again ingest the leaves of the herbaceous *Desmodium gangeticum*. Undigested, non-chewed leaves were found in 4% of wild chimp faeces and clumps of sharp-edged grass leaves were found in 2%. The leaves have a rough surface or sharp edges and the fact that they were not chewed and excreted whole indicates that they were not eaten for nutrition. Furthermore, leaf-swallowing was limited to the rainy season when parasite re-infections are more common and parasitic worms were observed besides the the leaves. *Aframomum angustifolium* products are eaten by chimps, bonobos and gorillas. Antimicrobial activity of homogenised fruit and seed extracts has been indicated in tests conducted.

A study on domestic sheep provided conclusive experimental evidence of self-medication *via* individual learning. Lambs in a treatment group were given foods and toxins (grain, tannins, oxalic acid) that cause malaise and then

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given a substance known to relieve each malaise (sodium betonies, polyethylene glycol and dicalcium phosphate, respectively). The control lambs ate the same foods and medicines as the sick lambs but they were separated temporally, so they did not recover from their illness. Following conditioning, lambs were fed grain or food containing tannins or oxalates before being given the opportunity to select one of three medicines. The treatment animals preferred to consume the specific compound known to alleviate the state of malaise caused by the previously consumed food.